The article "A mathematical model to improve water storage of glacial lakes prediction towards addressing glacial lake outburst floods" provides a simple method to estimate Moraine Dam glacier lake volume estimations based on data that can easily be obtained from permanently updated global datasets.

Major comments,

The model calculates the volume for an ideal case when the lake is symmetrical. Although unrealistic, it is a considerable improvement from the empirical equations that look into the area of the lake to estimate the volume. However, this equation relies on the right selection of r, m and n. How confident are you in the estimation of these parameters? I appreciate that the authors provide simple relationships, but I am concerned with the potential overfitting of the empirical thresholds. According to the validation section, they used 40 out of 44 lakes to come up with the thresholds and then validated the method using the 4 lakes that they left behind. Can the authours elavorated on this calibration/validation strategy?

**Explanation and revision:** Thank you very much for your affirmation and questions. We first simplified the model into four equations, with their solutions all dependent on the correct selection of *m*, *n*, and *r*. Based on the geometry of the glacial lake, we established a proportional relationship between *m*, *n*, *r*, and the glacier lake length (*l*). This proportional relationship is empirically defined and essentially represents a geometric segmentation of the glacial lake. The lake is divided into three sections, and the volume of each section is calculated separately. The total water storage of the lake is then obtained by summing the volumes of these three sections.

Therefore, we first used measured data from four glacial lakes to validate whether this proportional relationship was appropriate. After validation, we found that the empirically derived proportional relationship performed well. Hence, this study adopts this proportional relationship as the standard for the model's input parameters. No calibration or adjustments were made during this process. We have added the following explanation in lines 243 to 248 of the original text: " Based on the geometry of the glacial lake, we established a proportional relationship between m, n, r, and the glacier lake length (l). This proportional relationship is empirically defined and essentially represents a geometric segmentation of the glacial lake. The lake is divided into three sections, and the volume of each section is calculated separately. The total water storage of the lake is then obtained by summing the volumes of these three sections."

Regarding the validation section you mentioned, my approach is as follows: First, I use the data from four moraine-dammed lakes measured by our team in previous years to validate the accuracy of the model's input parameters and estimation results. Then, I collected post-1990 glacier lake measurement data (44 lakes) as a sample set to compare and validate the estimation accuracy of our model against other published methods. Therefore, Section 4.1 of the paper focuses on model validation, while Section 4.2 compares our model with other approaches. Therefore, the threshold values for the model's input parameters were not determined from measured data but were primarily based on the segmentation of the glacial lake's geometric shape. All measured data in this study were used solely for model validation and to compare the accuracy of our model with other methods.

The previous comment applies to Figure 8 and Table 6 as well. If the available equations are compared in the same lakes where this model was calibrated, the exercise is biased, and it should be compared with independent data.

**Explanation and revision:** Thank you very much for your suggestions. There is no parameter that needs to be trained or calibrated, all parameters can be measured through the glacial lakes and their surrounding topology. Regarding the validation section you mentioned, I did not clearly explain the entire rationale and process for model validation. Therefore, based on the suggestions from all reviewers, I have added a new subsection in the methodology section: 3.4. Model validation and application.

**3.4. Model validation and application**

In this study, we initially validated our parameterization using bathymetric measurements from four representative glacial lakes surveyed between 2020 and 2021. Subsequently, we combined the data from these four lakes with the remaining six glacier lakes we measured, along with water storage data from 34 MDLs obtained from relevant literature sources (see Appendix A for details). This resulted in a dataset of 44 lakes, which was used to compare and validate the performance of our model against other existing methods.

A glacier lake inventory of the High Mountain Asia region, published by Wang et al, 2020 was used as input data for the model application to assess the water storage of moraine-dammed lakes in this region. Notably, Wang's glacier lake inventory provides a detailed classification of GCL and GUL, which has been internationally recognized. It is important to note that in his dataset, GUL refers specifically to glacier lakes that do not contact glaciers, which may not necessarily all be moraine-dammed lakes. We conducted a thorough review and made revision to ensure that we retained only those GULs classified as moraine-dammed lake.

Also, since there are four types of lakes (GCL-1, GCL-2, GUL-1, and GUL-2), the comparison should be shown by type of lake.

**Explanation and revision:** Thank you very much for your suggestion. However, after careful consideration, we did not differentiate between glacier lake types in the revised manuscript. The primary reason is that in our model, moraine-dammed lakes are subdivided into four categories to improve estimation accuracy, whereas other methods do not classify lake types. Therefore, further subdividing the results for comparison when estimating water storage would be meaningless.

Minor comments.

How do you standardize R to make it comparable to other glaciers? Does it provide an indication of potential growth through elongation, for example? For example, in line 129, when you mentioned "newly formed," does it mean that it has the potential to grow at a higher rate? In that case, how do you define new?

**Explanation and revision:** Your question is very interesting. First, regarding the standardization of R, we mention in lines 124-129 of the paper that R represents the ratio of the maximum width to the maximum length of a moraine-dammed lake. Therefore, the value of R ranges between 0 and 1, as the width of a glacier lake is always less than its length (see Figure 4). The definitions of glacier lake length and width are provided in lines 220-225. Hence, the R values of all glacier lakes can be directly compared.

Based on glacier lake inventory data, high-resolution remote sensing imagery, and R-values, it can be observed that R can provide an indication of potential growth through elongation. For example, when the R-value is relatively small, it suggests that the glacier lake may be expanding in length.

Newly formed glacier lakes indeed have the potential to grow at a higher rate. This is because such lakes typically belong to the GCL type, receiving abundant glacier meltwater, which accelerates their rapid expansion. It is important to clarify that we do not determine whether a lake is newly formed based on the R-value, but rather through multi-temporal remote sensing imagery. Newly formed moraine-dammed lakes often exhibit relatively high R-values, as their length and width are not significantly different during early formation. As shown in Figure 5, GCL-1 lakes have an R-value of 0.75, which is much higher than that of other glacier lake types.

It would be useful to provide a general explanation of why the value of R would go from 0.1-0.6 in a GCL 2 lake to 0.5-1 when it gets detached from the glacier (GUL1) and the glacier continues to retreat. There is an example, but I am thinking as a general definition.

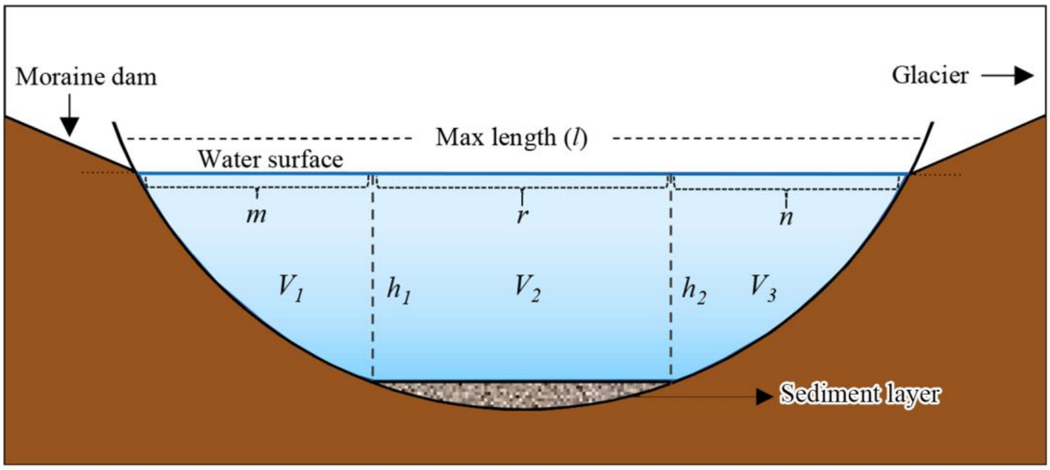
**Explanation and revision:** Thank you very much for your question. Regarding why the R-value of GCL 2 lakes ranges from 0.1 to 0.6, while that of GUL 1 lakes ranges from 0.5 to 1, these two categories are not directly comparable. Our model is designed by first classifying moraine-dammed lakes into two main categories, GCL and GUL, with R-values ranging between 0 and 1 for each category. Therefore, the R-values can be compared within the same type of glacier lake.

In line 140 "through statistical analysis of glacial lake sizes for different types, we defined the threshold for R", which method and statistical significant of the values?

**Explanation and revision:** Thank you very much for your question. Regarding the determination of the R-value threshold, we first classified moraine-dammed lakes into two major categories, GCL and GUL, based on glacier lake inventory data. Then, we extracted the R-values for each category and performed descriptive statistics, including mean, median, mode, variance, and standard deviation. Based on the geometry of moraine-dammed lakes, we defined a threshold, such as 0.7 for GCL. Lakes with an R-value greater than or equal to 0.7 are categorized as GCL-1, while those with an R-value less than 0.7 are categorized as GCL-2. During the experimental process, this threshold of 0.7 was not determined in a single step but was finalized after multiple trials, comparing it with the geometry of moraine-dammed lakes.

Figure 3: A small figure with the axis direction would be appreciated, as would Figure 2, which is in a yz plane according to my interpretation.

**Explanation and revision:** Thank you very much for your suggestion. After considering the comments from other reviewers, we have revised Figure 2. Regarding your suggestion about the axis direction, I did not fully understand the specific meaning. Could you please clarify?




Line 199: if r=0 and n=0, m has to be m>0; so this sentence inline 200 "and in most cases, m is not equal to zero" makes no sense. If m =0, after indicating that r=0 and n=0, it means that there is no lake.

**Explanation and revision:** I sincerely apologize for the misunderstanding caused by my unclear description. In the vast majority of cases, m is greater than zero. However, there are instances where it can be equal to 0. For example, the Lake Zhasuo Co (93.25°E, 30.31°N) in southeastern Tibet, m=n=0, because the surface morphology of this lake is rectangular. This point has been clarified in the paper (L203-206).

How do you account for the potential ice at the bottom of the lake?

**Explanation and revision:** Thank you very much for your question. My understanding is as follows: Some moraine-dammed lakes evolve from proglacial lakes (GCL), and before these lakes expand to their maximum extent controlled by the surrounding topography, the ice thickness at the glacier terminus remains relatively large and has not yet completely melted. In this scenario, ice may still exist at the lake bottom.

Does figure 8-a axis y refer to errors?

**Explanation and revision:** Figure 8-a: The y-axis refers to the lake volume derived from the model.

Line 395 says, “The underwater landforms of some MDLs are not always completely flat.” Are they ever flat?

**Explanation and revision:** Thank you for your question, which made me realize that my wording was not precise enough. What I intended to convey is that the bottom of moraine-dammed lakes is not always a smooth parabolic shape. Therefore, we have revised the sentence to: "The underwater landforms of some MDLs are not always a smooth parabolic shape."

Why Jialong Co and Bienong Co are representative of the other 42 lakes for the sensitivity analisys?

**Explanation and revision:** Because Jialong Co and Bienong Co as representatives of GUL and GCL of MDLs, respectively. Additionally, both moraine-dammed lakes are relatively large in size, and their water depths exceed 130 m.